Assessment of nationally representative dietary studies in the GCC: A scoping review

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Background. Obesity is at a record high in Gulf Cooperation Council (GCC) countries and is expected to continue increasing. Diet is a major contributor to this disease, but there is inadequate nationally representative dietary research from these countries. We aimed to quantify the number dietary studies using food frequency questionnaires (FFQs) that have been conducted in individual GCC countries, and to assess the quality of eligible studies.

Methodology. Two databases (PubMed and Web of Science) were searched for keywords; records were screened for eligible studies and data were abstracted on study characteristics (e.g., publication year, geographical locations, sample size, units of measurements, number of foods examined, number of Arab foods and key findings). Quality was assessed using an adapted Newcastle-Ottawa Quality Assessment Scale for cross-sectional studies.

Results. Only six studies were eligible from four GCC countries (Saudi Arabia, Bahrain, Kuwait and Qatar). All eligible studies used FFQs, but only 17% used a validated questionnaire, and none of the studies used a validated Arabic questionnaire or any additional tools to measure diet. Fifty percent of studies made an effort to include local foods. The majority of studies (67%) either measured frequency or quantity of food consumed, but only 33% attempted to account for both frequency and quantity.

Conclusions. The quality of studies varied and major weaknesses of FFQ validity and adaptability have been highlighted. More dietary investigations are needed using validated FFQs that have been adapted to the local GCC diets. Using reference tools will allow for better dietary estimations.

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Abstract

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Introduction

Obesity is an epidemic in the countries of Gulf Cooperation Council (GCC) (i.e., Saudi Arabia, Bahrain, Kuwait, Oman, Qatar, and United Arab Emirates); approximately one out of every three adults is obese (Body Mass Index ≥30), and the obesity prevalence has been rising in every member country. For example, between 2011 and 2016, the obesity prevalence rose in Saudi Arabia (KSA) from 32.1 to 35.4%, in Bahrain from 27.1% to 29.8%, in Kuwait from 35.1% to 37.9%, in Oman from 23.7% to 27%, in Qatar from 31.8% to 35.1%, and in the United Arab Emirates (UAE) from 28.3% to 31.7% (1). Apart from obesity, the GCC countries are also leading countries in the world in diabetes and cardiovascular disease prevalence (2–4).

There is mounting evidence of a potential causal link between specific dietary factors (e.g., fruit, vegetable, processed meat, and trans-fat intake) and the above mentioned chronic conditions (5–7). A recent systematic review of dietary data from 195 countries found that 22% of all adult deaths worldwide are due to unhealthy diet; more than half of diet-related deaths are attributable to a high sodium intake, low intake of whole grains, and low fruit intake (8).

Given the high prevalence of chronic conditions in the GCC, one would expect that these countries engage extensively in diet and nutrition research. However, dietary studies have been limited; the research output from Arab countries constitutes ≈ 1% of global research (9). Their *h*-

indices [measurement of performance by combining productivity (number of papers) and impact (number of citations)] are much lower than neighbouring non-Arab countries (10).

One would similarly expect that assessment tools used in dietary studies from GCC countries would differ from those in European or North American studies as Middle Eastern diets vary a great deal from their western counterparts. For example, date palm fruit is highly consumed in Gulf regions with daily consumption ranging from 68 – 164 g daily (11–13), whereas only 140 g of this fruit is consumed *annually* in Europe (14). Differences such as these should be accommodated for when designing dietary assessment tools.

The usual assessment tools used in dietary research are 24-hour dietary recall (open-ended, food consumed the previous day, conducted by trained interviewer), diet records (open-ended, participants trained to record own diet), and food frequency questionnaires (FFQs) (closed-ended, typically a food list and frequency of consumption in a given period,). All have strength and limitations (15), but due to low cost, low respondent burden and ease of use compared to other methods, FFQs are thought to be the best choice for measuring habitual diet in large populations. The usefulness and reliability of FFQs have been demonstrated with strong correlations with diet records (16,17), dietary recalls (18–20), and objective biomarkers of diet (18,19). As an FFQ is a self-reported subjective tool, FFQs should be tested for validity alongside a reference tool.

We aimed to conduct both a quantitative and qualitative review of all dietary studies conducted within each GCC country. To be as nationally representative as possible, we looked at studies carried out in multiple regions (must be a minimum of two regions) to provide a current and more reflective picture of diet in the GCC. We assessed dietary research that used FFQs in individual GCC countries (Bahrain, Kuwait, Oman, Qatar, KSA, UAE) over the past ten years (2009-2019). We described the characteristics of the studies and assessed their quality using a widely accepted scoring tool (21,22). Our objectives were to (1) identify multi-regional GCC dietary studies that used FFQs, (2) assess the quality of the studies, and (3) offer recommendations for future dietary assessments.

Method

SEARCH STRATEGY AND INCLUSION CRITERIA

We conducted this review in May 2019. We searched the PubMed and Web of Science databases using the following terms: “diet,” “frequency questionnaire” in combination with each of the Gulf Cooperation Council countries (i.e., “Bahrain”, “Kuwait”, “Oman”, “Qatar”, “Saudi Arabia”, “UAE”). We identified 275 records from PubMed (n = 241) and Web of Science (n= 34). We removed the duplicates (n=30) and screened the unique records (n=245) with the following inclusion criteria: (1) assessed diet using a food frequency questionnaire, (2) included data from multiple regions/cities (minimum two) of the Gulf country of focus, and (3) data was collected in the last ten years (i.e., 2009 and later).

EXCLUSION OF STUDIES

Studies were excluded if they (1) examined data from only one specific region/city/population group and therefore were not necessarily nationally representative, (2) were multi-national studies that did not give Gulf-nation-specific results, (3) were not conducted in a GCC country, (4) were intervention studies where the diet had purposefully been changed, (5) were review or meta-analysis papers, (6) used an assessment tool other than a food frequency questionnaire, or (7) had no findings related to diet or did not report those findings. Therefore, our final analysis was limited to six dietary studies (*Fig. 1*).

DATA CHARTING PROCESS

After an initial search and screening, we charted the following data from each study: publication year, author(s) name(s), geographical location, sample size, age range of participants, dietary assessment tool(s) used, units of measurement (e.g., times/week, servings/day, etc.), total number of foods examined, number of Arab-specific foods (and where possible, the type and name of food), whether the questionnaire was validated, and dietary findings related to the most common foods studied. Any discrepancy was resolved through discussion and consensus among the authors.

CRITICAL APPRAISAL OF STUDIES

Using a scoring system adapted from Newcastle-Ottawa Quality Assessment Scale for cross-sectional studies (21), we scored each study for (1) representativeness of the sample, (2) sample size, (3) non-respondents, (4) ascertainment of the exposure, (5) adaptability, (6) assessment of the outcome, and (7) statistical test (*Appendix 1*).

DATA ANALYSIS

Trial characteristics, along with main findings related to dietary intake/habits were tabulated. Additionally, indicators of study quality were assigned point values based on the quality assessment scoring scale and then summed. Each study was categorized as excellent (9-12 points), satisfactory (5-8 points), or unsatisfactory (0-4 points).

Results

STUDY CHARACTERISTIC

The search resulted in six studies published between 2009 and 2019. *Table 1* shows three studies were conducted in Saudi Arabia, one in Kuwait, one in Bahrain, and one in Qatar; there were no studies from Oman or the UAE. A majority of the studies (n=5) had sample sizes greater than 1000 participants, and all studies included a sample size justification. Almost all studies had a 1:1 male: female ratio (range 1: 0.9-1.4 male: female). Sixty-seven percent (n=4) of the studies were carried out with adolescents (12-19 years of age), whereas 33% (n=2) included both adolescents and adults.

All studies used FFQs, but two administered the FFQ through face-to-face interviews; the rest were self-administered. One study (23) used pictures to deduce serving sizes.

The number of food items assessed ranged from two (non-specified fruits and vegetables) (24) to 18 items (25). Only one of the six studies used a validated questionnaire, adapted it for local cuisine, and had it pilot tested for suitability (25), whereas the other five studies did not use validated FFQs.

Key findings from each study varied based on the units of measurements. Frequency ranged from days per week, times per day, servings per day, to categories (e.g., always, sometimes, never). Quantity options were servings per day, serving sizes, and serving sizes via selection of pictures.

QUALITY ASSESSMENT OF STUDIES

None of the included studies used a validated Arabic questionnaire (all were presented in English in the article) or any additional tools to measure diet. Musaiger et al. (25) modified a previously validated questionnaire (Family Eating and Activity Habits Questionnaire) (26) and adapted it to ensure it reflected dietary habits of the target population. Contents of the FFQ were validated by experts in the field of nutrition, public health, and epidemiology and the questionnaire underwent pilot and test-retesting (25).

Table 2 shows 50% (n =3) of the studies made an effort to include local foods, scoring a point for adaptability, whereas the other three studies either did not incorporate any local foods or did not mention it in their studies.

Four studies measured either frequency *or* quantity, whilst two studies scored the maximum three points for 'assessment of outcome' by having units of measurements that took into account both frequency and quantity (e.g., times/week *and* servings/day).

All studies used appropriate statistical analysis and had an adequate response rate (≥60%), but one study did not compare between respondent and non-respondent characteristics or take non-responses into account (or did not mention it in their study) (27).

Discussion

With such a high prevalence of diseases to which diet is a major contributor, it is surprising that there are so few multi-regional studies that investigated diet in the GCC in the past ten years. Five out of the six studies included in this review did not use validated FFQs.

Dietary summaries show intake of fruit and vegetables being far below the recommended three servings of vegetables and two servings of fruit per day (28). In Saudi Arabia, only 5.2% of individuals met the recommendation for fruit intake and 7.5% for vegetable intake. In contrast, consumption of sugared beverages was oversubscribed, with an average of 36% of adolescents (14-19 years old) reporting daily consumption (27) and 27% of 15-60 year olds (23), exceeding local and global recommendations of sugared-drink consumption (29–31). This low fruit and

vegetable intake, combined with high sugared-beverage consumption, suggests a poor-quality diet across the GCC.

The varying methods of measuring diet made it difficult to compare consumption. For example, 50% of the studies assessed diet using frequency questions (e.g., how often), whilst 50% measured frequency and quantity (portions or serving size). At times, the response categories were too broad for in-depth analysis. For example, "Do you regularly consume meals? Yes/No" (25) does not specify which meals, how many meals, or the content of the meals. Similarly, "How often do you drink a glass of milk?" (32) does not quantify the size of the glass or the amount of milk consumed.

Adaptability was one of the main issues relating to study quality according to the quality assessment scoring scale. Studies need to make it explicit how they have categorized foods, e.g., whether they have classified potatoes as starch, tuber, snack, fast food, etc. Only three studies attempted to include local foods, with a maximum of two or three items added (and mentioned in the article) (23,31,33). It is concerning that 50% did not mention any native foods at all. In Tabacchi's review (34), it is suggested that an FFQ with less than 70 food items reduces the quality of nutritional information that can be deduced. None of the studies included in this review had 70 items; the most was 18, the average being less than ten (9.5) items. Nutritional status and dietary patterns differ over time and from region to region; without the incorporation of local foods and without categorizing them under more common food groups, it is entirely possible to mask important epidemiological links between diet and disease.

An overall poor validity of FFQs was found in this review. Only one study used a validated FFQ and scored two points out of a possible four points on the quality assessment scale. Validation in large-scale studies is especially important as FFQs are prone to measurement errors and come with inherent self-bias. FFQs rely on an individual's memory and his/her own perception of food sizes, thus under-reporting remains a common problem (35–38). Researchers have made extensive efforts in the last two decades to mitigate some of the errors with self-reporting data (39–41), but diet and eating patterns are complex, and FFQs are still thought to have clear value and insight that solely objective measures cannot provide (42,43). One of the ways to minimize errors is to use a validated FFQ. FFQs are not one-size-fits-all, and it is integral that questionnaires be adapted/modified to suit the population with which they are being used. This includes first developing a good FFQs to standard procedure (44), FFQs being in the native language, which for GCC is predominantly Arabic, and including as many local foods as possible.

Limitations of this review are that our search was limited to two main databases; this may have missed studies published in other journals not found within these databases, and those that are currently underway or not yet published. However, additional cross-checking was performed with reference lists to ensure the maximum number of studies were screened. The small number of studies limited the generalisability of findings.

A particular strength is the quality assessment aspect of this review. Adapting a scoring system allowed for objective assessment of studies. It highlighted that most of the included

studies were either satisfactory (n=4) or excellent (n=2), whilst making it clear that the greatest weaknesses were in the number of food items and the validity and adaptability of FFQs, which researchers should take into consideration when designing future studies. Another strength is that the review focused on large-scale, multi-regional studies, which are more representative of the respective GCC nations' populations. To our knowledge, there are no other reviews of this nature, i.e., quality assessment of dietary studies focusing on GCC countries.

RECOMMENDATIONS

As validity and adaptability were the lowest scoring categories, it is important to address this.

1. Validation can be assured by using a reference method. There are a variety of other methods used to measure diet, including self-reporting food records and 24-hour dietary recall (24-HDRs), but the most objective reference tool is food or nutrient biomarkers (15,45). In theory, biomarkers look like a promising method to remove the human error that comes with self-reported diets, but their widespread use is hindered because there are only a few known and validated biomarkers. One of the well-known biomarkers could be used as a reference measurement to validate FFQs and to assess their accuracy.
2. As KSA is the largest of the GCC countries, a quality assessment of all FFQs used in KSA should be undertaken. Comparisons should be made to see how similar they are, how inclusive they are of local cuisine and if the questionnaires are validated. This will be a labour-intensive task as it is our finding that questionnaires are rarely attached to articles or submitted as supplementary material; thus, authors will need to be contacted for original FFQs. This will give an overview of the versions of FFQs available and the Arabic food items included. By noting what foods are *not* represented in these questionnaires, additional foods can be added and attempts made to validate the FFQ. A recent FFQ developed by Gosadi et al. (2017) is a promising start for KSA (46). The Arabic FFQ had 140 food items and ensured it had a comprehensive food list by comparing it with open-ended information from 24-hour dietary recalls to find that 85% of food items recalled were covered in the FFQ. The FFQ has been piloted and its reliability assessed (Cronbach's alpha test and test-retest) and it should now be used in other regions. This standard of FFQ development should be carried out with other GCC countries as well to better capture dietary habits.

The review only included cross-sectional studies because they give a current picture of diet (observations of diet at a given point in time). Carrying out a longitudinal study analysis (repeated observations of a population over time) would allow us to see how diet has changed over time to make better-informed future predictions.

Conclusions

This is the first review to collect, quantify and critique the quality of data on the dietary studies conducted in GCC countries by using an objective scoring system approach. Study quality varied, and major weaknesses of FFQ validity and adaptability have been highlighted.

Findings consistently showed that the majority of GCC populations are not meeting the recommended fruit and vegetable recommendations, and sugared-beverage consumption is on the rise, implying a poor diet. However, interpretations are made with caution due to the low study sample included (n=6). In these GCC countries, where obesity levels are steadily rising, more dietary investigations are necessary. The use of validated FFQs in conjunction with other instruments like biomarkers, 24-hour recalls and/or food records is likely to provide more accurate dietary estimations.

In conclusion, it is essential that researchers develop well-designed, validated FFQs that are adapted for the GCC to standardise dietary assessments across studies.

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Figure 1 Flow chart of study eligibility of dietary studies conducted in GCC countries.

Table 1(on next page)

Table 1 Study characteristics of national dietary assessment studies conducted in Arab Gulf countries (n=7).

*where possible, names of Arab food have been included

number

SSB: sugar sweetened beverages

1 **Table 1 Study characteristics of national dietary assessment studies conducted in Arab Gulf countries (n=7).**

2

				Tool(s) used					
Author	**Country**	**Age range**	**Sample size**	**Type**	**# of total food items**	**# and type of Arab food***	**Measurement**	**Validated**	**Findings**
Al Baho & Badr, 2011(33)	Kuwait	13 - 15	2674 (1399 male; 1275 female)	FFQ (2011 Kuwait GSHS)	6 (includes breakfast meal)	2 *Coriander* (vegetable); *KDD*, *KDcow*, *Carnation* (dairy)	times/day in past 30 days (except breakfast: how often in last 30 days: Never, Rarely, Sometimes, Mostly, Always)	Not validated	Over 30 days, 36% of students usually ate fruits (≥2 times/day); 19% ate vegetables (≥3 times/day); 75% consumed soft drink (≥1 times/day); 36% drank milk (≤2 times /day); 48% had fast food (≥3 times/week).
AlBuhairan et al., 2015(31)	Saudi Arabia	12 - 19	12575 (6444 male; 6131 female)	FFQ (Global School-based Student Health Survey)	8 (includes meals)	2 *Fatayer* (snack); *molokhiya* (vegetable)	srvgs/day breakfast: last 30 days (never, rarely, some, most, daily) Number of main meals	Not validated	38% of adolescents ate ≥1 srvgs/day of fruit and 54.3% ate ≥1 srvgs/day of vegetables. 38% drank ≥2 carbonated beverages/day.

							per day? (0 - >4)		
Al-Hazzaa et al., 2011(27)	Saudi Arabia	14 - 19	2908 (1401 male; 1507 female)	FFQ (Arab Teen Lifestyle Survey (ATLS))	9 (includes meals)	None	days/wk	Not validated for dietary questions	In Saudi adolescents, an average of 22.8% consumed vegetables daily; 12.8% had fruit daily; 29.15% had milk daily; 62.35% consumed sugar-sweetened beverages (SSB) (> 3 day/week); 27.55% fast food (> 3 day/week); 27.85% french fries/potato chips (> 3 day/week); 26.8% cake/donut/biscuit intake (> 3 day/week); 44.95% sweets/chocolates intake (> 3 day/week); 50.65% energy drinks intake (> 3

									day/week).
Haj Bakri & Al-Thani, 2012(24)	Qatar	18 - 64	2496 (1053 male; 1443 female)	FFQ via face-to-face interviews STEPS Instrument (WHO 2005) adapted for Qatar-specific context)	2	None	days/wk AND srvgs/day	Not validated	91% of the Qatari studied population consumes <5 srvgs/day of fruits and/or vegetables. Average number of fruit servings was 0.8 srvgs/day. Average number of vegetable servings was 1.4 srvgs/day. Overall average combined fruit and/or vegetable servings was 2.2 srvgs/day.
Moradi-Lakeh et al., 2017(23)	Saudi Arabia	15 - 60+	10735 (5253 male; 5482 female)	FFQ via interview; pictures of serving sizes	14	2 *Laban* and *labneh* (yogurt products)	days/wk in the last year AND g/day or ml/day	Not validated	11% of subjects ate fruits daily and 26% ate vegetables daily. 27% drank SSB daily. Dietary guideline

									recommendations for fruits were met by only 5.2% of participants and 7.5% for vegetables. 85% met the recommended intake for meat and 80% met recommendations for processed meats.
Musaiger et al., 2011(25)	Bahrain	15-18	735 subjects (339 male; 396 female)	FFQ	18 (includes meals)	None	times/wk fast food/soft drinks: times/wk AND typical srvg size meals: regularly (yes/no) snacking: always, sometimes, never	Modified from validated questionnaire and pilot-tested	Approximately 25% of respondents reported eating fruit daily, 27.7% consumed fruit rarely (<1 time/week). 26% consumed vegetables daily, 38% of respondents rarely (<1 time/week). 37% consumed dairy products daily; 22% rarely (<1 time/week).

				20% consume meat daily; 21.5% rarely (<1 time/week). 14.4% of participants ate fast food daily, 29% rarely (<1 time/week). Soft drinks: 42.2% of participants consume soft drinks daily; 27.8% rarely (<1 time/week).

*where possible, names of Arab food have been included
number
SSB: sugar sweetened beverages

Table 2(on next page)

Table 2 Quality assessment of national dietary assessment studies conducted in GCC countries using a scoring system (n=7).

Table 2 Quality assessment of national dietary assessment studies conducted in GCC countries using a scoring system (n=7).

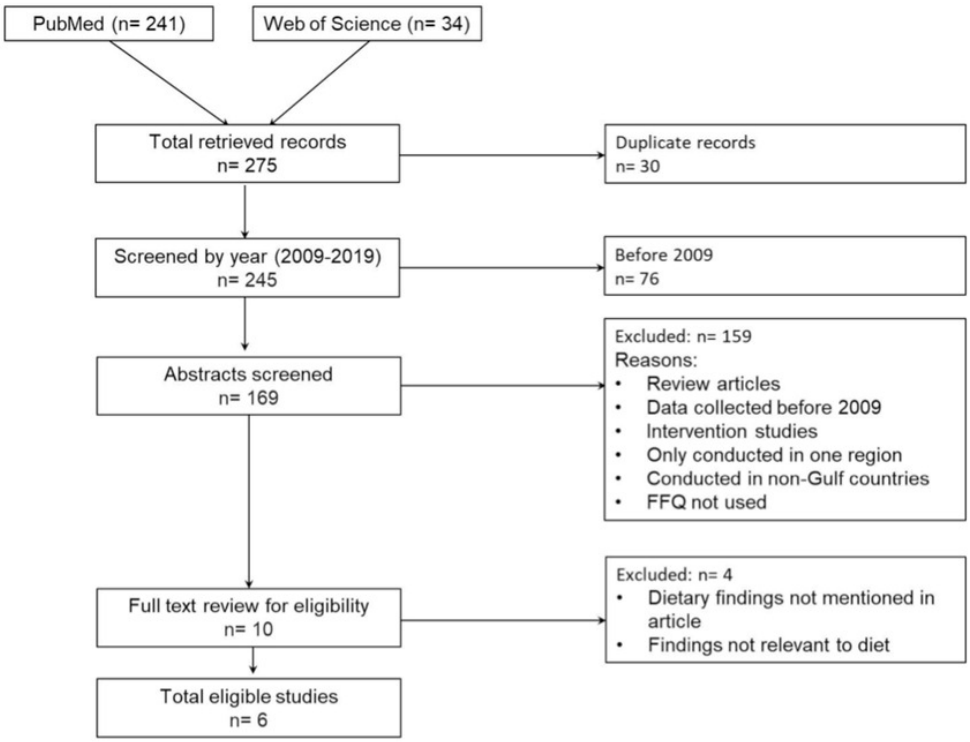
		Selection					Outcome		Total
Author	**Design**	**Representative of sample**	**Sample size**	**Non-respondents**	**Ascertainment of exposure (validated)**	**Adaptability**	**Assessment of outcome**	**Statistical test**	**Score (out of 12)**
Al Baho & Badr, 2011(33)	cross-sectional	+	+	+	+	+	++	+	**8**
AlBuhairan et al., 2015(31)	cross-sectional	+	+	+	+	+	++	+	**8**
Al-Hazzaa et al., 2011(27)	cross-sectional	+	+		+		++	+	**6**
Haj Bakri & Al-Thani, 2012(24)	cross-sectional	+	+	+	+		+++	+	**8**
Moradi-Lakeh et al., 2017(23)	cross-sectional	+	+	+	+	+	+++	+	**9**
Musaiger et al., 2011(25)	cross-sectional	+	+	+	++		+++	+	**9**

2

3

Figure 1

Figure 1 Flow chart of study eligibility of dietary studies conducted in GCC countries.


PubMed (n= 241)
Web of Science (n= 34)
Total retrieved records
n= 275
Duplicate records
n= 30
Screened by year (2009-2019)
n= 245
Before 2009
n= 76
Abstracts screened
n= 169
Excluded: n= 159
Reasons:
• Review articles
• Data collected before 2009
• Intervention studies
• Only conducted in one region
• Conducted in non-Gulf countries
• FFQ not used
Full text review for eligibility
n= 10
Excluded: n= 4
• Dietary findings not mentioned in article
• Findings not relevant to diet
Total eligible studies
n= 6